DOCUMENT RESUME

ED 262 988 SE 046 201

TITLE	Simple Assessment Techniques for Soil and Water. Environmental Factors in Small Scale Development Projects. Workshops.
INSTITUTION	Coordination in Development, New York, NY.
SPONS AGENCY	Agency for International Development (IDCA), Washington, DC.
PUB DATE	[84]
NOTE	36p.
PUB TYPE	Guides - General (050)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	*Agriculture; Community Programs; Conservation (Environment); *Developing Nations; *Laboratory Procedures; Microbiology; Natural Resources; Physical Environment; *Soil Conservation; *Technical Assistance; *Water Resources
IDENTIFIERS	*Appropriate Technology

ABSTRACT

This booklet was produced in response to the growing need for reliable environmental assessment techniques that can be applied to small-scale development projects. The suggested techniques emphasize low-technology environmental analysis. Although these techniques may lack precision, they can be extremely valuable in helping to assure the success of small-scale development projects. Tests that deal with significant features of soil and water are discussed. These include: (1) soil pH; (2) soil texture; (3) percolation; (4) dissolved minerals; (5) sodium in water; and (6) coliform bacteria. Each test contains background information, a materials list, suggested procedures and an interpretation section. A field practice data sheet and a situation data sheet are also included. (ML)

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Environmental Factors in Small Scale Development Projects

WORKSHOPS

SE 046 201

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SIMPLE ASSESSMENT TECHNIQUES

FOR SOIL AND WATER

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CONTENTS

Preface	ii
Introduction	iii
Test #1: Soil pH	1
Test #2: Soil Texture	5
Test #3: Percolation	10
Test #4: Dissolved Minerals	14
Test #5: Sodium in Water	16
Key for Suitable Irrigation Conditions	19
Test #6: Coliform Bacteria	22
Field Practice Data Sheet	27
Situation Data Sheets	29
Field Notes	31

PREFACE

This booklet was prepared for a workshop on "Environmental Factors in Small-Scale Development Projects" at Lake Mohonk, New York, June 17-19, 1980, by Dr. Timothy S. Wood, then Director of Environmental Studies, Wright State University, Dayton, Ohio. Dr. Wood is now serving in West Africa with Volunteers in Technical Assistance (VITA). The workbook was developed from an initial draft by Dr. Gus Tillman, Cary Arboretum, which presented these tests to earlier workshops. Also involved in early versions were Carol Roever and Helen Vukasin, CODEL, and Keith Smiley, Mohonk Consultations on the Earth's Ecosystem, Dr. Nail Ozerol, Howard University, and Craig Tufts, National Wildlife Federation.

This draft has been further revised by Helen L. Vukasin, CODEL, based on technical reviews by Dr. Ralph Martin, University of Oklahoma, Norman; Dr. Frederic K. Pfaender, University of North Carolina, Chapel Hill; Rev. John Ostdiek, Mundelein College, Chicago; and Dr. August Haffenraffer, Millipore Corporation, Bedford, Massachusetts.

CODEL welcomes your comments and suggestions on the usefulness of the booklet. We are particularly interested in knowing about experience with the tests in the field.

CODEL Environment and
Development Program

"A first step toward low technology environmental analysis."

INTRODUCTION

Among project planners in developing countries, there is a growing need for reliable environmental assessment techniques. The most effective methods are often those which are very simple, using locally available materials. While they may be primitive and lack precision, such methods can be extremely valuable in helping to assure the long-term success of small-scale development projects.

The techniques described in this booklet represent a first step toward low-technology environmental analysis. What is surprising is how much useful information can be gained with so little equipment. These tests deal with significant features of soil and water, and with reasonable care, the results can be meaningful and reliable.

Certainly, such simple tests are not intended to substitute for detailed, long-term environmental impact studies. Many problems in soil and water analysis are complex, requiring the services of trained and experienced technicians. Where such services are unavailable, however, the preliminary assessment techniques described here can prove very useful.

TEST #1: SOIL pH

Background. One of the simplest and most useful soil tests is the measure of acidity or alkalinity, called pH. Not only does it provide important clues about soil fertility, but it can also help determine the types of plants best suited for that soil as well as suggest possible means of improving the soil for better crop production.

The pH scale ranges from 0 to 14. At pH 7 the soil is neutral; below that level it is acidic, and above 7 the soil is alkaline (basic). Since pH is based on a logarithmic function, a change in a single pH unit indicates a ten-fold change in acidity or alkalinity.

Materials

pH indicator paper[1]
Rainwater
Small container, such as a plastic film canister
Soil sample (dry)

Procedure

1. Collect a sample of soil representative of the field you wish to analyze. The soil should be dry and loose, without any hard clumps.

2. Add rainwater to the soil and mix to make a thin, watery mud.

3. Dip one end of a strip of pH indicator paper into the mixture and allow water to be drawn up the paper, which acts like a wick.

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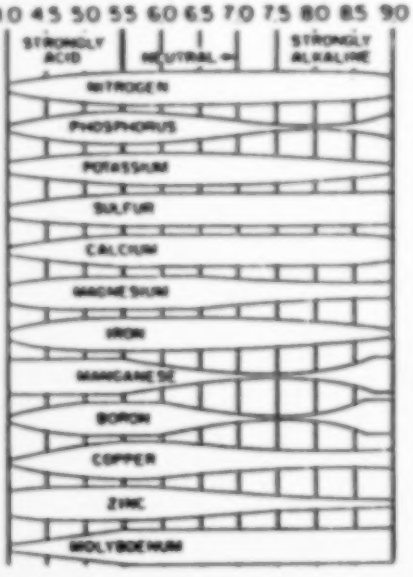
[1]pH indicator paper is available at laboratories and some pharmacies. It can be ordered from:

Micro Essential Laboratory, Inc.
4224 Avenue H
Brooklyn, New York 11210 U.S.A.
(Phone: 212-338-3618)

4. Match the color of the wet paper to one of the bands on the color comparator chart to find the approximate pH.[1]

5. NOTE: The pH paper should not remain in the mixture for any extended length of time. After five minutes or so it is possible to get a false reading, as the rising water washes out dye at the base of the strip and concentrates it near the leading edge of the water column.

Interpretation. A close relationship is found between soil pH and the nutrients available to a growing plant. Figure 1 (below) shows the effects of pH on 12 such nutrients, where the wider the band the greater the availability. Clearly, strongly acid soils are deficient in many dissolved nutrients, while strongly alkaline soils have little available phosphate. Like all living things, plant growth depends on that essential nutrient which is available in the least quantity. Therefore, whether it is one nutrient or ten nutrients that are unavailable to the plant, the growth restriction will be the same.



(Figure 1 is from R.E. Lucas and J.F. Davis, Department of Crop and Soil Sciences, Michigan State University.)

[1] A color comparator is supplied with the pH paper.

If you were to select a pH that would have available the greatest number of plant nutrients, you would be correct to choose something around 5.5. Nonetheless, every plant species has its own special pH preferences. Suitable pH ranges for selected plants are given in Table 1 (below).

Acidic soils can be made more alkaline by the addition of ground limestone, ground seashells, or wood ashes. Decreasing the pH of alkaline soils is much more difficult. Traditionally, ammonium sulfate is used, but composted organic material also helps.

Testing for pH in soils is useful wherever crops are grown. It is especially important before and during any program for irrigation, fertilization, or soil improvement.

The pH of water is easily measured, but is has little significance in agricultural projects. It would be incorrect to assume, for example, that irrigating with acid water will create an acid soil. The pH of water, however, may be of concern for fisheries projects. So many different factors combine to establish the soil pH that it usually is better to just measure the soil pH alone.

TABLE 1. SUITABLE pH RANGES FOR SELECTED CROPS

Crop	pH
Alfalfa	6.3 - 7.5
Apples	5.7 - 7.5
Asparagus	6.0 - 7.0
Barley	5.5 - 7.0
Beans, Lima	5.5 - 6.8
Beans, Snap	5.5 - 6.5
Beans, Velvet	5.5 - 6.5
Blueberries	5.5 - 5.8
Buckwheat	5.2 - 6.5
Cabbage	5.7 - 7.0
Carrots	5.7 - 7.0
Clover, Alaska	5.3 - 7.0
Clover, Crimson	5.5 - 7.0
Clover, Red	6.0 - 7.0

Table 1 (continued)

Crop	pH
Clover, Sweet	6.5 - 7.5
Clover, White	6.0 - 7.0
Corn	5.5 - 7.0
Cotton	5.5 - 6.5
Cowpeas	5.5 - 7.0
Cucumber	5.5 - 6.8
Grasses, many kinds	5.5 - 7.0
Kale	5.3 - 6.5
Lettuce	6.0 - 7.0
Mustard	5.5 - 6.5
Oats	5.5 - 7.0
Onions	6.0 - 6.8
Parsnips	5.5 - 6.8
Peas	6.0 - 7.0
Peppers	5.5 - 6.5
Potatoes, Sweet	5.0 - 5.8
Potatoes, White	5.0 - 5.2
Radishes	5.5 - 6.5
Rye	5.5 - 7.0
Sorghum	5.5 - 7.0
Soybeans	5.5 - 7.0
Spinach	6.0 - 7.0
Squash	5.5 - 6.5
Strawberries	5.2 - 6.5
Sudangrass	5.5 - 7.0
Timothy	5.7 - 7.3
Tobacco	5.0 - 6.0
Tomatoes	5.5 - 6.8
Wheat	5.5 - 7.0

TEST #2: SOIL TEXTURE

Background. The expression, "soil texture" refers to the various sizes of rock particles in the soil. Traditionally, the spectrum of sizes is classified into at least three types: sand (0.05 - 2 mm. diameter), silt (0.002 - 0.05 mm. diameter), and clay (under 0.002 mm diameter). Most soils are a mixture of these sizes, but where one predominates, one can speak of a "sandy soil" or a "silty soil," etc.

The following procedure is a simple way to identify the particle composition of a soil sample. It is based on the principle that when suspended together in a jar of water, the larger particles will settle faster than the smaller ones. The taller the jar and the greater the settling distance, the better will be the separation.

Materials

Tall glass jar with lid
Water
Soil sample

Procedure

A. Visual Test

1. Add a loose soil sample to fill approximately one-third the volume of the jar. There should be no hard clumps, and preferably no pieces of leaves, stems, or other organic debris.

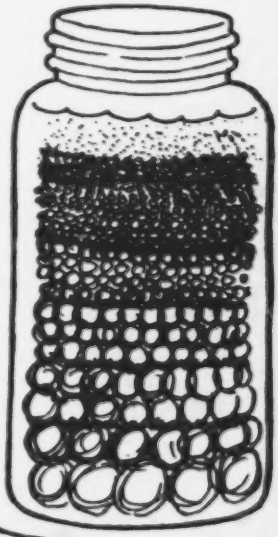
2. Fill the jar nearly to the top with water, cap it, and shake the mixture to suspend all the individual soil particles. Then let the jar stand undisturbed. Most of the particles will settle within a half hour, although many of the smallest clay particles will not settle for a week or more.

3. The settled particles will take on the appearance of distinct bands or layers. While there is probably a continuum from large to small,

the rough fraction of each size class can be estimated.

B. "Feel" Test

1. Moisten a sample of soil and feel it in your fingers. Roll the soil between the thumb, fore and middle fingers. Try to form a small ball. Check to see if soil will form a long thin ribbon or ribbon out. Soils may stick to the hands and soil them. Determine the textural class of the soil according to Table II.



Allow the suspended mixture to settle. The settled particles will form distinct layers.

Try to form a ball by rolling the sample between your fingers.

13

Interpretation. By learning the texture of a soil sample, one can also know some of its chemical and physical properties.

For example, sandy soil tends to be relatively infertile and vulnerable to drought. However, the rapid rate of percolation (see Test #3) promotes good aeration for beneficial soil organisms and plant roots. Sandy soil can safely accept irrigation with water containing a high concentration of dissolved minerals, while such water would be unsuitable for "heavier" soils.

Where water is scarce and the soil is sandy, the addition of organic material before crops are planted--and afterwards as a mulch--can help retain moisture. A wise choice of irrigation methods will also help increase the productivity of sandy soil in parched climates (see Chapter 6 in Environmentally Sound Small-Scale Water Projects by Gus Tillman (New York, CODEL/VITA, 1981).

Clay soil can hold and retain a larger amount of water than sandy soil, and it resists the leaching of nutrients. Unfortunately, low percolation in clay soil leads to water-logging and poor aeration. Clay soil exposed to a hard rain often dries with a hard-baked surface. Further drying causes clay soils to contract, opening deep cracks which seriously damage plant roots. These conditions may be improved by: a) adding sand to the soil, and b) applying a mulch of organic materials to protect the soil from driving rain and to prevent complete drying.

"Loam" is a term for a mixture of soil types that provides a good medium for growing plants. While there is room for much variation, a good loam may be approximately 40% sand, 40% silt, and 20% clay. With organic material and an adequate water supply, such soils can become highly productive.

TABLE
CHARACTERISTICS OF THE

Soil Textural Class	Feel (moist)	Ability to Form Stable Ball[1]
SAND	Very gritty	No
LOAMY SAND	Very gritty	No
SANDY LOAM	Gritty	Yes (easily deformed)
LOAM	Gritty	Yes
SILTY LOAM	Velvety	Yes
SILTY CLAY LOAM	Velvety and sticky	Yes (very stable)
CLAY LOAM	Gritty and sticky	Yes (very stable)
SANDY CLAY LOAM	Very gritty and sticky	Yes (very stable)
SILTY CLAY	Extremely sticky and very smooth	Yes (very resistant to molding)
CLAY	Extremely sticky with slight grittiness	Yes (very resistant to molding)

II

MAJOR SOIL TEXTURAL CLASSES

Ability to Ribbon Out [1]	Soils Hands [1]	Consistency Moist	Consistency Dry
No	No	Loose	Loose
No	Yes (slight)	Loose	Loose
Yes (dull surface, poorly formed)	Yes	Very friable [2]	Soft
Yes (dull surface, poorly formed)	Yes	Friable [2]	Soft
Yes (dull surface, poorly formed)	Yes	Friable [2]	Soft
Yes (shiny surface, well formed)	Yes	Friable [2] to firm	Slightly hard
Yes (shiny surface, well formed)	Yes	Firm	Slightly hard to hard
Yes (very shiny surface, well formed)	Yes	Friable [2] to firm	Slightly hard to hard
Yes (very shiny surface, well formed)	Yes	Firm to extremely firm	Hard to very hard
Yes (very shiny surface, well formed)	Yes	Firm to extremely firm	Hard to very hard

Adapted from Foss, et al.,
A Laboratory Manual for Soil Science, 1976.

1. See explanation under B. 1.
2. Crumbles easily.

TEST #3: PERCOLATION

Background. Percolation is the movement of water through wetted soil. The force behind the movement is gravitational,[1] although some capillary action[2] and plant root osmosis[3] may also occur. Many factors affect the rate of percolation, such as:

a) Soil texture - water passes more quickly through large pores in sandy or loam soils than through heavy silts and clays.

b) Soil structure - fine-structured soils with stable aggregates[4] pass water more easily than unstructured soils.

c) The amount of water already in the soil - in saturated soils there are fewer cracks and pores through which water can pass readily.

d) The organic content of the soil - organic material maintains a loose soil structure that facilitates percolation.

e) The depth of soil to bedrock, laterite,[5] hardpan,[6] or other impermeable layers.

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1. The pull toward the center of the earth.
2. Action by which the surface of a liquid where in contact with a solid is elevated or depressed.
3. Diffusion or absorption through a membrane.
4. Hard inert rock.
5. Type of rock, red in color with a high proportion of iron oxides and hydroxide of aluminum.
6. A compacted layer of soils.

When soil permits moderate to high percolation, it is said to be "well drained." Such soil may support vigorous root growth by allowing excess water to drain away, leaving air openings through which the roots can "breathe." In irrigation projects, a well-drained soil means less chance of water-logging or salt accumulation.

When water is poured over the surface of dry soil it will usually soak in rapidly for a while. This temporary situation is known as infiltration, not percolation, and it happens only while the water is filling open spaces in the soil. It is only after this phase that true percolation occurs - the movement of water through wetted soil. When conducting a test for percolation, it is important to avoid this confusion with infiltration.

Materials

"Tin" can with top and bottom removed
Water - equal to the volume of the can
Dipstick - any stick will do
Ruler
Rock - for pounding
Board - about 30 cm. long

Procedure

1. Sink the can into the soil until its upper rim projects 8-10 cm. above the surface. Do this by placing the board across the top of the can and pounding it down with the rock. It is very primitive, but it works (unless one encounters a large rock, in which case try a different location).

2. Remove the can from the soil and the soil that comes with it, leaving a round hole in the ground.

3. Pour some water into the hole to a depth of 2-3 cm. Allow the water to stand for ten minutes, then re-fill, if necessary, to the original depth. This allows time for infiltration. If the soil is very dry, it may require more time and more water to complete this initial phase of water movement.

4. Measure the depth of water in the hole. Do it several times to be sure your measurements are consistent. Measure the depth again one hour later. Calculate the change in depth during that hour. If time permits, let the system go for a second or third hour, and then determine the hourly rate of percolation.

Measure the depth of water in the hole with a marked stick placed against a horizontal board across the hole.

Interpretation. Percolation rates are generally classified as follows:

a) Very low: rates of less than 0.25 cm. (0.1 inch) per hour.

b) Low: rates of 0.25 = 1.25 cm (0.1 - 0.5 inch) per hour.

c) Medium: rates of 1.25 - 2.5 cm. (0.5 - 1.0 inch) per hour.

d) High: rates greater than 2.5 cm. (1.0 inch) per hour.

Uses. Projects in which testing soil percolation would be significant include:

a) Fishpond construction, where the desired percolation rate would be zero, and where the testing should be conducted at many locations to the maximum depth of the proposed pond.

b) Irrigation projects, where it is necessary to know how fast water will sink below the root zone. Percolation and infiltration rates should both be considered if there are to be long, unlined channels conducting irrigation water to the fields.

c) Construction of latrines, lagoons, or any other in-ground sewage disposal system. When percolation rates are high, these systems can handle a relatively high volume of liquid wastes, but disease-causing organisms may be carried over 100 meters through the soil. Soils with low percolation rates present problems with clogging and low capacity, but the pathogens are generally contained within 30 meters.

TEST #4: DISSOLVED MINERALS

Background. Most surface and subsurface waters contain a certain amount of dissolved minerals. Many of these are essential for plant growth, although in high concentrations their effects can be harmful. No standards for irrigation water quality are possible since so much depends on soil drainage, climate, types of crops, and specific minerals in the water.

The following test can be considered useful in providing only a rough guide to the mineral content of water. Combined with other soil information, the test results can be helpful in planning agricultural projects.

Materials

- Glass - flat, smooth, and clean, at least 40 $cm.^2$ in area. A hand mirror or any piece of window glass would be fine
- Eyedropper, or any other device that can release one drop of water at a time (drinking straw, smooth stick, etc.)
- Rainwater - only a very small amount is needed, but it must be clean. Collect in clear glass container.

Procedure

1. Prepare the glass so that it is absolutely clean and dry. It must be so clean that a drop of water will bead on its surface.

2. Place the piece of glass in a level position where it will not be disturbed.

3. Make 5 separate puddles of water. Start #1 with 4 drops of rainwater for control. For each of the other puddles combine different amounts of rainwater and test water as described below:

Puddle	Rainwater	Water to be Tested
#1	4 drops	0 drops
#2	3 drops	1 drop
#3	2 drops	2 drops
#4	1 drop	3 drops
#5	0 drops	4 drops

4. Allow all puddles to dry undisturbed.

Interpretation. If there is a mark left by the rainwater alone, it should be only barely discernible; otherwise the test is void and should be repeated with cleaner rainwater. The remaining water marks should fit one of the following descriptions:

a) Marks left by puddles #2-5 are rings in which the centers are clean. LOW MINERAL CONTENT (less than 700 mg/1).

b) Marks left by puddles #2-5 are rings; the central area is clean in #2-3, but in #4-5 a slight film residue extends throughout the area. MEDIUM MINERAL CONTENT (700-1800 mg/1).

c) Marks left by puddles #4-5 are not distinct rings, but instead form a more-or-less uniform blotch on the glass, often distinctly granular, sometimes not drying completely unless heated. HIGH MINERAL CONTENT (more than 1800 mg/1).

There will, of course, be conditions intermediate to these descriptions, and these will be subject to the investigator's best interpretation.

The mineral test by itself does not provide much useful information. Only when combined with the infiltration test (Test #3) and specific mineral tests (such as Test #5) do the results gain significance, especially for irrigation projects. Examples of how to use combined results of several tests for irrigation projects is illustrated by the Key for Suitable Irrigation Conditions, pp. 19-21.

TEST #5: SODIUM IN WATER

Background. A high mineral content does not necessarily make any water unsuitable for irrigation. However, if one of those minerals is sodium, the use of such water for irrigation can cause serious damage to the soil. A high concentration of sodium in the water will break down soil aggregates, sealing the pores and reducing the infiltration rate to almost zero. In most cases, the changes are irreversible.

The following test is normally used to distinguigh between hard and soft waters. However, when the mineral content of the water is known to be high, the test can be used to assess the relative proportion of sodium ions.

Materials

A small, water-tight container with lid, such as a plastic 35 mm film canister
Soap or soap solution (but not detergent)
Rainwater or distilled water

Procedure

1. Make a soap solution by adding some soap flakes (shaved from a bar of soap with a knife or razor blade) to some rainwater. Allow the mixture to sit for several hours, then filter gently through a cloth to remove any remaining soap particles. Try not to make suds.

2. Standardize the strength of your soap solution as follows: fill the container halfway with rainwater. Find the minimum number of drops of soap solution required to maintain frothy suds for at least five minutes after the mixture has been shaken vigorously for 5 seconds. This amount of soap solution will be your "standard dose."

3. Empty, and rinse the container with rainwater. Re-fill halfway with the water to be tested. Add the standard dose of soap, close the container, and shake it vigorously for 5 seconds.

Open the container and note the condition of the mixture.

Interpretation. The shaken mixture should match one of the following descriptions:

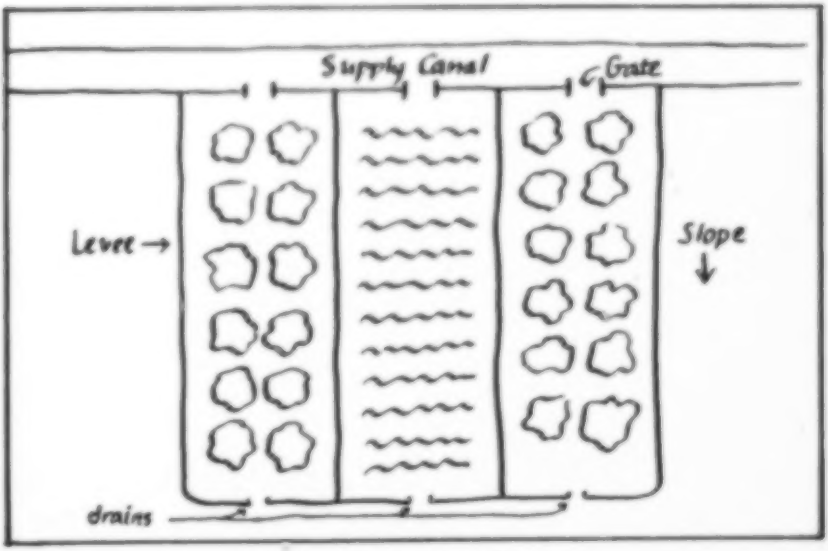
a) Suds cover the surface. This indicates a HIGH SODIUM RISK.

b) The water appears cloudy. This indicates a MEDIUM SODIUM RISK.

c) A white sum floats on the surface. This indicates a LOW SODIUM RISK.

Note that this test must be performed in conjunction with Test #4, Dissolved Minerals. The sodium test is meaningful only when the dissolved mineral content is medium or high.

Together, these tests are essential before irrigation projects are undertaken.



Border Irrigation

From Tillman, Environmentally Sound Small-Scale Water Projects, op. cit., p. 7.

KEY FOR SUITABLE IRRIGATION CONDITIONS

On the following two pages is a key to assist with an assessment of environmental conditions suitable for an irrigation project. The key assumes that a supply of water for irrigation exists and that the impact of withdrawing the water from its present source has already been examined.

A key such as this presents a series of choices to the user in a significant sequence. Begin with pair #1, select the statement (a or b) whichever best fits your information, and proceed to the numbered pair of statements indicated by the numeral on the right. When you encounter a letter in the righthand column, refer to the box below for an explanation.

For example:

A. If you choose #1a, go next to statement #2.
   If you choose #2a, go next to statement #3.
   If you choose #3a, go next to C which indicates that conditions are unsuitable for irrigation.

B. If you choose #1b, go next to statement #4.
   If you choose #4b, go next to statement #5.
   If you choose #5a, go next to statement #6.
   If you choose #6b, go next to statement #7.
   If you choose #7b, go next to A which indicates that conditions are suitable for irrigation.

KEY FOR A ROUGH ASSESSMENT OF CONDITIONS SUITABLE FOR IRRIGATION

1. a. Ground water often comes to within 1.5 meters of soil surface. 2
   b. Ground water seldom comes within 1.5 meters of soil surface 4

2. a. Mineral content of irrigation water is low (Test #4). 3
   b. Mineral content of irrigation water is medium or high. C

3. a. Percolation rate is very low C
   b. Percolation rate is not very low . . . . . B

4. a. Mineral content of irrigation water is low (Test #4) 6
   b. Mineral content of irrigation water is medium or high. 5

5. a. Sodium risk in irrigation water is low (Test #5) 6
   b. Sodium risk in irrigation water is medium or high C

6. a. Percolation rate is very low (Test #3) C
   b. Percolation rate is not very low 7

7. a. Percolation rate is low . . . . . B
   b. Percolation rate is medium or high . . . . . A

A. CONDITIONS ARE SUITABLE FOR IRRIGATION.
B. CONDITIONS ARE MARGINAL FOR IRRIGATION.
C. CONDITIONS ARE UNSUITABLE FOR IRRIGATION.

This key is a crude scheme for interpreting simple field data. It is not intended for use independent of extended professional surveys and testing.

TEST #6: COLIFORM BACTERIA

Background. The contamination of water supplies with disease-causing organisms is a serious problem in many parts of the world. However, detecting such contamination can be tricky. Water that appears clean and without taste or odor may, in fact, be swarming with extremely dangerous bacteria, viruses, and parasites from human feces.

Fortunately, testing for each individual pathogen is unnecessary. The common practice is instead to seek the presence of a relatively harmless bacterium that is common in the fecal wastes of all warm-blooded creatures. These so-called coliform bacteria are represented by a species known as Escherischia coli, or E. coli, whose presence can be easily detected by anyone having the proper equipment. The assumption is that water containing E. coli is contaminated by by fecal material and could also contain dangerous pathogens. While several different techniques serve to detect coliform bacteria, one of the simplest methods uses a simple plastic dip stick with a filter which holds 1 ml. of water. It was developed by Millipore Corporation. It is called a Millipore Sampler. Several types with different media for growing the cultures are available to measure coliform, total bacteria or yeast and mold counts.

Materials

Millipore Sampler for Coliform or Coli-Count Sampler[1]
Incubator
The skin of or place next to a person

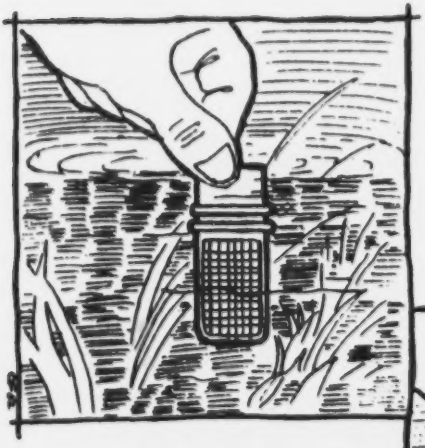
---

1. Can be ordered from Millipore Corporation, Order Service Department, Bedford, Massachusetts, U.S.A. 01730. Telex: 92-3457, Wire TWX: 710-326-1938. Phone: 800-225-13807 or 617-275-9200.

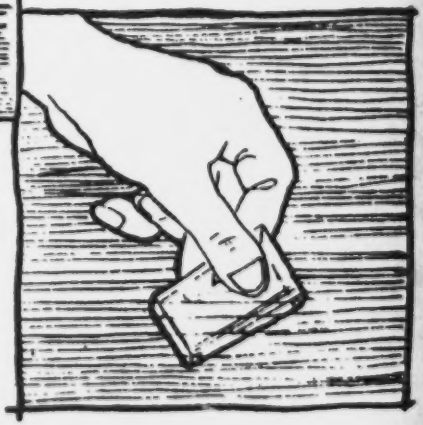
Procedure

1. Remove the stick (with the grid lines) from the clear plastic case. Allow nothing to touch the grid to protect the sterilization.

2. In still water the sampler may be dipped directly into the water. Alternatively, fill the clear case to the upper line with a sample of water to be tested. It is very important that the water not be inadvertantly contaminated by bacteria from your fingers. If sampling from a stream, point the mouth of the case upstream into the direction of water flow. Hold for several minutes. When sampling from a well, fill a clean container with water without wetting your fingers, and pour the contents carefully into the clear plastic case up to the line.



"In still water the sampler may be dipped directly into the water."



"If sampling from a stream point the mouth of the case upstream..."

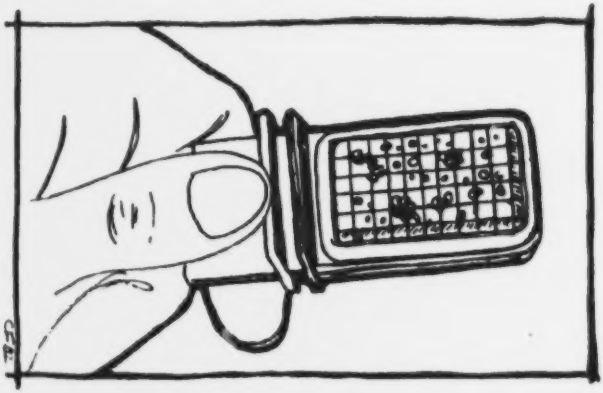
3. Insert the sampler all the way into the filled case, shake several times, and then hold the case still for 30 seconds. During this time, the sampler will absorb exactly 1 ml. of water.

4. Remove the sampler and shake it several times to remove excess water. Be careful not to contaminate it by allowing it to touch any surface.

5. Empty the case and shake it to remove excess water.

6. Insert the sampler into the empty case. The whole apparatus must now be placed in an environment that maintains a continuous temperature of 35°C. or 98.6°F. for 18-24 hours. If using a human body to create the incubation environment, the sampler should be taped against the skin.

7. After 18-24 hours, examine the paper grid for signs of coliform bacterial colonies. There may be many spots on the sampler, but only those which are raised, shiny, and either blue or blue-green are colonies derived from single coliform bacteria. Count the number of colonies. If there are no colonies visible, see caution below.



"Count the number of colonies."

Interpretation. The appearance of coliforms indicates that pathogenic organisms, such as those responsible for typhoid, dysentery, and cholera, may be present. Generally, more than two colonies on the sampler indicates water unsafe for drinking.[1] However:

a) recently sunk wells or bores will often have an unduly high coliform count for several weeks;

b) decomposing non-sewage material in the water can prompt a false reading. There are some non-fecal bacteria in soil which can be mistaken for coliforms of recent fecal origin. These may occur especially if the incubation temperature has not been kept sufficiently high.

A Note of Caution. E. coli or coliform bacteria is only an indicator of contamination. Because it involves incubation and sterile conditions it is more difficult to do correctly than other tests described here. This method serves particularly well in situations where monitoring of water quality is needed or as a first crude measure in considering a water project. In some cases a test by a professional laboratory may be essential. Negative results should not be accepted

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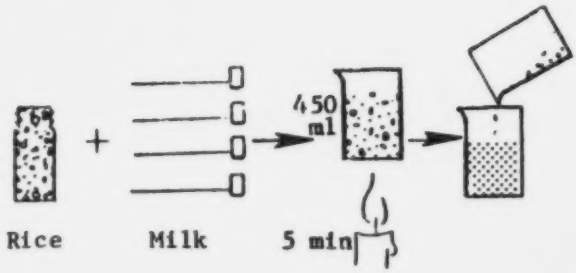
[1] International agencies disagree on standards. Some scientists believe only water without any colonies of E. coli is safe. Others believe that water with less than 4 colonies per 100 ml. is safe. Still others believe that if the whole world had access to water with less than 10 colonies per 100 ml. we would be approaching the aim of safe water for all. In some areas the best that can be done is to reduce the number of colonies to a range of 50-100 per 100 ml. To determine what is an achievable level for your area check with the local government agency responsible for water quality or with a local health agency. Testing for coliform/100 ml. must be done in a laboratory.

without repeating the test. Also caution should be exercised in reading results to note certain external factors: a recent heavy rain run-off may increase contamination; a temporary event of another kind may interfere with results.

Alternative Methods. Another way of determining contamination is by placing the test water in a culture medium that will indicate if E. coli are present by production of gas. Construction of a kit that can be put together in the field and how to make the tests with the kit are described in George Reid, Water Test Kit I, User's Manual, University of Oklahoma, 1975. $2.00. Available from CODEL.

"Preparing medium for coliform test." Taken from Water Test Kit I, User's Manual, cited above.



FIELD PRACTICE DATA SHEET

NAME _____

TEST #1 - SOIL pH.

Soil Sample No. _____ Soil pH _____

TEST #2 - SOIL TEXTURE

_____% sand, _____% silt, _____% clay

Textural classification: _____

TEST #3 - PERCOLATION (may be done in groups)

Percolation rate: _____ per hour.

Test duration: _____ hours.

TEST #4 - DISSOLVED MINERALS

Water Sample No. _____

Level of dissolved minerals: _____

TEST #5 - SODIUM (if applicable)

Water Sample No. _____ (same as in Test #4)

Sodium risk: _____

SITUATION DATA SHEET

Date_____ Time _____

Location: County_____ State_____

Direction and distance from nearest town post office:

_____

Weather, past 24 hrs._____

_____

Current weather_____

Topography _____

_____

Ground cover _____

Color of topsoil _____

Color of subsoil_____ Depth _____

Soil texture classification _____

_____% sand, _____% silt, _____% clay

Other particles _____

Depth of soil sample_____

Percolation rate: ___ _____ per hour

Percolation test duration _____ hours.

Soil pH _____

Evidence and type of erosion _____

_____

WATER.

Source of water_____

_____

Color_____ Transparency_____

Dissolved solids_____Sodium risk_____

pH_____ Temperature range_____

Coliforms_____ per 100 ml.

Sources of possible contamination (sewage, pesticides domestic or industrial waste, animals, surface run-off, etc.). Describe nature of contaminant and distance from point of water use.

_____

_____

_____

History of water-borne disease in the region:

cholera_____

dracontiasis_____

filariasis_____

malaria_____

schistosomiasis (bilharzia)_____

typhoid_____

yellow fever_____

other_____

_____

Reference: Gus Tillman, Environmentally Sound Small Scale Water Projects, N.Y., CODEL/VITA, 1981. Order from VITA, 1815 North Lynn, Suite 200, Arlington, Virginia 22209

Published with partial support from U.S. Agency for International Development, Office of Private and Voluntary Cooperation.